

Appln No. 10/789,237

Amdt date August 11, 2005

Reply to Office action of May 13, 2005

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently amended) A sub-harmonic mixer comprising:
an input for receiving a first signal having a first frequency and a second signal having a second frequency;
an output for outputting a third signal having a third frequency; and

at least one diode ring array, each having a plurality of diode rings arranged in parallel, said diode rings having a diode,

wherein said diode comprises a field emission transistor (FET) or a high electron mobility transistor (HEMT),
and

wherein said at least one diode ring array receives the first signal and the second signal, generates a fourth signal having twice the second frequency, and multiplies the fourth signal to the first signal to generate the third signal.

2. (Original) The sub-harmonic mixer of claim 1, wherein said at least one diode ring array is coupled between at least one of the input and the output, and ground.

3. (Original) The sub-harmonic mixer of claim 1, wherein said at least one diode ring array is coupled between the input and the output.

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4. (Original) The sub-harmonic mixer of claim 1, wherein said at least one diode ring array comprises two diode ring arrays that form an image rejection mixer.

5. (Original) The sub-harmonic mixer of claim 1, wherein the mixer performs up-conversion, wherein the third frequency is higher than the first frequency.

6. (Original) The sub-harmonic mixer of claim 5, wherein the first frequency is an IF frequency, the second frequency is an LO frequency, and the third frequency is an RF frequency.

7. (Original) The sub-harmonic mixer of claim 1, wherein the mixer performs down-conversion, wherein the first frequency is higher than the third frequency.

8. (Original) The sub-harmonic mixer of claim 7, wherein the first frequency is an RF frequency, the second frequency is an LO frequency, and the third frequency is an IF frequency.

9. (Currently amended) A transmitter comprising:

a sub-harmonic mixer having at least one diode ring array, each having a plurality of diode rings arranged in parallel, said diode rings having a diode, the sub-harmonic mixer receiving an intermediate frequency (IF) signal and

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translating the IF signal to a transmission signal having a transmission frequency; and

an oscillator for generating a local oscillator (LO) frequency signal having an LO frequency,

wherein said diode comprises a field emission transistor (FET) or a high electron mobility transistor (HEMT),
and

wherein the sub-harmonic mixer receives the LO frequency signal, generates a signal having twice the LO frequency, and multiplies the signal having twice the LO frequency to the IF signal using said at least one diode ring array to generate the transmission signal.

10. (Original) The transmitter of claim 9, further comprising an LO amplifier for amplifying the LO frequency signal prior to multiplying the LO frequency signal to the IF signal.

11. (Original) The transmitter of claim 9, wherein each said diode ring array includes four diode rings.

12. (Original) The transmitter of claim 9, wherein the at least one diode ring array comprises two diode ring arrays.

13. (Original) The transmitter of claim 12, wherein the sub-harmonic mixer further comprises a power divider for dividing the LO frequency signal to generate two divided LO

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frequency signals, and providing the two divided LO frequency signals to the two diode ring arrays, respectively.

14. (Original) The transmitter of claim 12, further comprising a hybrid for receiving the IF signal and generating first and second quadrature IF signals that are provided to the two diode ring arrays, respectively.

15. (Original) The transmitter of claim 12, wherein the sub-harmonic mixer further comprises a hybrid for combining outputs of the two diode ring arrays to generate the transmission signal.

16. (Original) The transmitter of claim 9, further comprising a filter coupled to at least one of input and output ports of the sub-harmonic mixer.

17. (Original) The transmitter of claim 16, wherein the filter is implemented as a triplexer.

18. (Original) The transmitter of claim 9, wherein the sub-harmonic mixer is implemented on an MMIC chip.

19. (Original) The transmitter of claim 9, wherein the diode rings are coupled between a common connection point and ground.

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20. (Original) The transmitter of claim 9, wherein the diode rings are coupled between input and output ports of the sub-harmonic mixer.

21. (Original) The transmitter of claim 9, wherein the transmission frequency includes at least one of a sum of said twice the LO frequency and the intermediate frequency, and a difference between said twice the LO frequency and the intermediate frequency.

22. (Currently amended) A method of generating a transmission signal having a transmission frequency from an intermediate frequency (IF) signal, comprising:

generating a local oscillator (LO) frequency signal having an LO frequency;

generating a signal having twice the LO frequency using a sub-harmonic mixer including at least one diode ring array, each having a plurality of diode rings arranged in parallel, said diode rings having a diode comprising a field emission transistor (FET) or a high electron mobility transistor (HEMT); and

multiplying the signal having twice the LO frequency to the IF signal using the sub-harmonic mixer to generate the transmission signal.

23. (Original) The method of claim 22, wherein each said diode ring array includes four diode rings.

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24. (Original) The method of claim 22, wherein the at least one diode ring array comprises two diode ring arrays.

25. (Original) The method of claim 24, further comprising dividing the LO frequency signal to generate two divided LO frequency signals, and providing the two divided LO frequency signals to the two diode ring arrays, respectively.

26. (Original) The method of claim 24, further comprising combining outputs of the two diode rings arrays to generate the transmission signal.

27. (Original) The method of claim 24, further comprising generating first and second quadrature IF signals using the IF signal, and providing the first and second quadrature IF signals to the two diode ring arrays, respectively.

28. (Original) The method of claim 22, further comprising filtering a signal on at least one of input and output ports of the sub-harmonic mixer.

29. (Currently amended) A receiver comprising:

a sub-harmonic mixer having at least one diode ring array, each having a plurality of diode rings arranged in parallel, said diode rings having a diode, the sub-harmonic mixer receiving a transmission signal having a transmission

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frequency and translating the transmission signal to an intermediate frequency (IF) signal; and

an oscillator for generating a local oscillator (LO) frequency signal having an LO frequency,

wherein said diode comprises a field emission transistor (FET) or a high electron mobility transistor (HEMT), and

wherein the sub-harmonic mixer receives the LO frequency signal, generates a signal having twice the LO frequency, and applies the signal having twice the LO frequency to the transmission signal using said at least one diode ring array to generate the IF signal.

30. (New) The sub-harmonic mixer of claim 1, wherein said diode rings comprise first, second, third, and fourth diode rings, each of said first, second, third, and fourth diode rings being electrically connected between a ground and a common connection point, said common connection point being electrically connected to said output.

31. (New) The sub-harmonic mixer of claim 30, wherein each of said first, second, third, and fourth diode rings comprises first and second diodes electrically connected with each other in an anti-parallel relationship.

32. (New) The transmitter of claim 9, wherein said diode rings comprise first, second, third, and fourth diode rings, each of said first, second, third, and fourth diode rings

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being electrically connected between a ground and a common connection point, and wherein the transmission signal having the transmission frequency is translated from the IF signal through said common connection point.